An Integrated Approach Focused on Air Quality Using in situ, Satellite, and Modeled Data in Near-Real-Time—Focus on Air Quality Forecast and the Future of Earth Observation Systems (EOS)

James Szykman
Environmental Engineer
ORD/NERL/ESD
(757) 864-2709
szykman.jim@epa.gov

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On July 31, 2003, the United Stated hosted 34 nations at the Earth Observations Summit in Washington, D.C. The summit participants discussed plans for achieving the goal of building a comprehensive, coordinated, and sustained earth observation system in the next 10 years, an objective stated by the G-8 Heads of State in June 2003. Such an earth observation system will benefit people around the world by linking different scales of observations to track global phenomena such as weather, climate change, and air quality. U.S. EPA's Office of Research and Development, National Exposure Research Laboratory (ORD/NERL) is an active participant in international and national workgroups to help define a framework and 10-year implementation plan for a Global Earth Observing System of Systems (GEOSS).

Working with our federal partners at NASA and NOAA, ORD/NERL is also leading the way in research and development to help prototype successful projects that can be used as a framework for building this comprehensive, coordinated, and sustained GEOSS using existing US assets from EPA, NOAA, and NASA. Just as Earth Observations from space revolutionized weather forecasting in remote areas in the 1960s, in which clouds and water vapor imagery allowed weather patterns to be identified and monitored, satellite sensors capable of detecting trace constituents can show the "chemical weather" or "pollution weather" over land and water. The potential benefit of such observations for air quality uses, such as forecasting and assessment, is comparable to the revolution experienced by weather forecasters with the advent of operational weather satellites decades ago. Remote sensing of trace gases and aerosols from space has matured rapidly over the past few years. Current instruments aboard NASA and European Space Agency satellites can provide derived measurements of trace gases and aerosols relating directly to most of the EPA's criteria pollutants (Burrows J., 1999; King et al., 1999; Fishman J., 2000). The retrieval of these derived measurements is now transitioning from scientific research and development to the routine near-real-time status required for use in operational settings.

During September 2003, a team of NASA, NOAA, and EPA researchers demonstrated a prototype project using satellite constituent observations in daily air quality forecasts. Aerosol observations (aerosol optical depth) from the MODIS sensor aboard the NASA EOS-Terra satellite (Kaufman et al., 1997; Tanré et al., 1997) were combined with other near-real-time datasets, including hourly $PM_{2.5}$ surface measurements and half-hourly wildfire locations, to improve forecaster knowledge of the synoptic-scale (large-scale) distribution and transport of particulate matter across North America. Data products were provided through a Web interface for use and evaluation by a group of forecasters working for state and local air management agencies. The data fusion of the data at these different spatial scales, both ground and satellite, provided air quality forecasters near-real-time views of large-scale particle pollution episodes.

This improved their knowledge on potential upwind influences for use in AIRNow next-day particulate matter forecasts that started on October 1, 2003. Based on positive response from air quality managers and forecasters, this prototype system has been implemented at the Cooperative Institute for Metrology and Satellite Studies, a joint NASA and NOAA center at the University of Wisconsin, Madison.

This project demonstrated the feasibility of bringing together data sets at different spatial scales to view the development of large-particle pollution episodes in near-real-time. By demonstrating the potential of use of aerosol optical depth data from satellites over the U.S., we showed the capabilities of current sensors to provide potential information on particle pollution episodes around the globe, bring us one step closer to a GEOSS.